

CLAIMS

1. A method for modifying an image comprising:
 - (a) receiving an image having a first bit depth;
 - (b) modifying said image to create a modified image resulting in a
5 second bit depth different than said first bit depth in such a manner
that the higher frequency content with respect to the lower
frequency content of said image is attenuated, and attenuating the
lower amplitude content of said higher frequency content with
respect to the higher amplitude content of said higher frequency
10 content;
 - (c) modifying said modified image based upon said modified image
and said lower frequency content of said image.
2. The method of claim 1 wherein said attenuation of said higher
15 frequency content with respect to said lower frequency content is
based upon a non-linear process.
3. The method of claim 1 wherein said attenuation of said higher
20 frequency content with respect to said lower frequency content is a
spatially varying process.
4. The method of claim 1 wherein said attenuation of said higher
frequency content with respect to said lower frequency content is
spatially varying non-linear process.
- 25 5. The method of claim 1 wherein said attenuating the lower
amplitude content of said higher frequency content with respect to

the higher amplitude content of said higher frequency content includes a coring function.

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6. The method of claim 5 wherein said coring function includes a hard-threshold.

7. The method of claim 5 wherein said coring function includes a transitional coring function.

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8. The method of claim 5 wherein said coring function includes a continuous 1st derivative.

9. The method of claim 5 wherein said coring function includes no discontinuity in actual value.

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10. The method of claim 1 wherein said received image of step (a) is represented by X bit depth.

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11. The method of claim 10 wherein said modified image of step (b) is represented by Y bit depth.

12. The method of claim 11 wherein $X > Y$.

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13. The method of claim 1 wherein said modifying of step (b) is a low pass filter.

14. The method of claim 1 wherein said modifying of step (b) wherein said lower frequency content is amplified.
- 5 15. The method of claim 1 wherein said modifying of step (b) changes the physical bit depth representation of the image.
16. The method of claim 1 wherein said modifying of step (b) does not change the physical bit depth representation of the image.
- 10 17. The method of claim 1 being performed in a manner free from including conditional statements.
18. The method of claim 1 being performed in a manner using a buffer smaller than 100 percent of said received image.
- 15 19. The method of claim 1 being performed in a manner using a buffer smaller than 30 percent of said received image.
- 20 20. The method of claim 1 being performed in a manner that is free from adding additional noise to said image.
21. The method of claim 1 being performed in a manner based upon the human visual system.
- 25 22. The method of claim 1 wherein said modifying includes reducing noise in regions proximate edges substantially to the same extent as noise in regions not proximate said edges.

23. A method for modifying an image comprising:

- (a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in artifacts, wherein said first bit depth is less than said second bit depth;
- (b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said artifacts that would have otherwise occurred;
- (c) wherein said modifying includes using a low pass filter.

24. A method for modifying an image comprising:

- (a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in artifacts, wherein said first bit depth is less than said second bit depth;
- (b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said artifacts that would have otherwise occurred;
- (c) wherein said modifying includes a filter that is based upon a selection of pixels of said image wherein at least of one said pixels is selectively not considered.

25. The method of claim 24 wherein said filter is a Sieve filter.

26. The method of claim 25 wherein said filter is represented by

$$I_{LP}(x, y) = \frac{\sum_{(i,j) \in E \& |I(i,j) - I(x,y)| < T} I(i, j)}{N(x, y)} .$$

27. The method of claim 24 wherein said artifacts are contouring artifacts.

28. The method of claim 24 wherein said filter is a 1-dimensional rectangle.

29. The method of claim 24 wherein said filter is a 2-dimensional rectangle.

30. A method for modifying an image comprising:

(a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in contouring artifacts;

(b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said contouring artifacts that would have otherwise occurred;

(c) wherein said modifying includes a sieve filter.

31. The method of claim 30 wherein said filter is represented by

$$I_{LP}(x, y) = \frac{\sum_{(i,j) \in E \& |I(i,j) - I(x,y)| < T} I(i, j)}{N(x, y)} .$$

32. The method of claim 30 wherein said filter is a 1-dimensional rectangle.
- 5 33. The method of claim 30 wherein said filter is a 2-dimensional rectangle.
34. A method for modifying an image comprising:
- 10 (a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in artifacts;
- (b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said artifacts that would have otherwise occurred;
- 15 (c) wherein said modifying reduces the energy remaining near an edge to substantially the same level as the energy remaining in regions not near an edge.
- 20 35. The method of claim 34 wherein said modifying of said image is based upon a non-linear process.
36. The method of claim 34 wherein said modifying is a spatially varying process.
- 25 37. The method of claim 34 wherein said modifying is spatially varying non-linear process.

38. The method of claim 34 wherein said modifying includes a coring function.

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39. A method for modifying an image comprising:

(a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in contouring artifacts;

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(b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said contouring artifacts that would have otherwise occurred;

(c) wherein said modifying includes a spatially varying non-linear filter that includes the following properties:

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(i) the amplitude of pixels within a region are subtracted from a pixel to calculate a delta for said pixel;

(ii) if said delta is greater than a threshold it is not used in a subsequent sum and average process;

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(iii) if said delta is not greater than a threshold undergo a said sum and average process comprising summing the value of said pixels within said region and dividing by the number of said summed pixels.

40. A method for modifying an image comprising:

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(a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in contouring artifacts;

5 (b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said contouring artifacts that would have otherwise occurred;

(c) wherein said modifying includes a spatially varying non-linear filter that includes the following properties:

(i) the amplitude of pixels within a region are subtracted from a pixel to calculate a delta for said pixel;

10 (ii) if said delta is greater than a threshold said pixel is replaced by the central value in a subsequent sum and average process;

(iii) all said pixels of said region are undergo a said sum and average process comprising summing the value of said pixels within said region and dividing by the number of said summed pixels.

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41. A method for modifying an image comprising:

(a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in artifacts;

20 (b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said artifacts that would have otherwise occurred;

25 (c) wherein said modifying includes applying a dithering technique to said image.

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42. The method of claim 41 wherein said modifying of said image is based upon a non-linear process.
43. The method of claim 41 wherein said modifying is a spatially varying process.
44. The method of claim 41 wherein said modifying is spatially varying non-linear process.
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45. The method of claim 41 wherein said modifying includes a coring function.
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46. A method for modifying an image comprising:
- (a) receiving an image having a first bit depth wherein modifying said image to a second bit depth would result in artifacts;
- (b) modifying said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated to reduce said artifacts that would have otherwise occurred;
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- (c) wherein said modifying includes applying an adaptive filter.
47. The method of claim 46 wherein said modifying of said image is based upon a non-linear process.
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48. The method of claim 46 wherein said modifying is a spatially varying process.

49. The method of claim 46 wherein said modifying is spatially varying non-linear process.
- 5 50. The method of claim 46 wherein said modifying includes a coring function.
51. A method for modifying an image comprising
- (a) receiving said image;
- 10 (b) processing said image to another bit depth different than said first bit depth in such a manner that the lower amplitude higher frequency content with respect to the higher amplitude lower frequency content of said image is attenuated;
- 15 (c) wherein said processing is characterized by at least one of the following:
- (i) said processing includes no conditional statements;
- (ii) said processing requires a buffer smaller than 100 percent of said image;
- 20 (iii) said processing requires a buffer smaller than 30 percent of said image;
- (iv) said processing requires a buffer smaller than 20 percent of said image;
- (v) said processing requires a buffer smaller than 10 percent of said image;
- 25 (vi) said processing includes a low pass filter;
- (vii) said processing is free from adding additional noise to said image;

(viii) said processing is based upon the human visual system;

(ix) said processing includes modifying said image in such a manner that the higher frequency content with respect to the lower frequency content of said image is attenuated.

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52. The method of claim 51 further comprising applying at least one of a dithering technique, an adaptive processing technique, and a coring technique, to at least one of said image, and said modified image.

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53. The method of claim 51 wherein said processing is characterized by at least said processing including no conditional statements.

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54. The method of claim 51 wherein said processing is characterized by at least said processing requiring a buffer smaller than 100 percent of said image.

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55. The method of claim 51 wherein said reducing of contours includes attenuating low amplitude high frequency content of said modified image.

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56. The method of claim 51 wherein said processing is characterized by at least said processing requiring a buffer smaller than 20 percent of said image.

57. The method of claim 51 wherein said processing is characterized by at least said processing requiring a buffer smaller than 10 percent of said image.

58. The method of claim 51 wherein said processing is characterized by at least said processing including a low pass filter.

5 59. The method of claim 51 wherein said processing is characterized by at least said processing is free from adding additional noise to said image.

60. The method of claim 51 wherein said processing is characterized by at least said processing based upon the human visual system.

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